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Inventor: R. Terry Wornath

APPARATUS FOR AND METHOD OF MANUFACTURING A PORTABLE HEATER

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to and includes an apparatus for use as a heater that may in certain embodiments be a portable heater and methods of manufacturing the same. The various apparatus and methods of the present invention may be of particular use in providing an efficient heater capable of construction with more robust materials. The present invention may provide many advantages including reducing hot spots and extending the useful life of the heater.

Description of the Art

[0002] Heating is a vital concern. Traditional methods of heating have included open fires, fireplaces, Franklin stoves, and radiators. The progress of innovation has not ignored the art of heating. Today there are a wide variety of techniques, methods, and apparatus for heating. An example of such a modern apparatus is provided in U.S. Patent No. 6,470,876, which describes a self-contained portable heater.

[0003] In general, heaters attempt to perform the process of heating the air efficiently in a relevant environment. Such an environment may, for example, be an airport hanger, a warehouse, or even a tent. Many heating devices that convert electricity into heat do so by means of the inherent losses of resistive metal (or other conductive) coils. These devices, thus, can consume significant amounts of electricity. Consequently, these approaches may entail considerable problems. For example, electricity is difficult to store and transport safely in large quantities. Resultantly, such heaters usually require connection to a source of external electric power. Additionally, because of the quantity of electricity consumed, the cost of operating such heaters is often significant.

[0004] Other heaters contain an alternative initial source of energy to be converted into heat. These may include, for example, kerosene, propane, or other fuel-air devices.

These devices may, in certain cases, contain catalysts or carburetors. One concern that arises in this context is the suitability for breathing of the gasses that are the immediate result of combustion (the combustion gasses, which may also include unoxidized fuel gasses, as well as other gasses such as atmospheric gasses or inhibitor gasses, such as nitrogen). These gasses frequently include large quantities of carbon dioxide, as well as significant quantities of carbon monoxide. Other gasses and airborne particles may also be found in the stream of combustion gasses. This stream, therefore, is generally not considered desirable for direct use as warm breathable air. Instead, the heat from the stream of combustion gasses must be transferred without transferring the contamination of the combustion gasses.

[0005] To solve the air quality problem described above, a heat exchanger is sometimes used to heat "clean" air on one side of the heat exchanger's boundaries with "combustion gas" on the other side. Although the word "clean" is used to describe this air, it is merely used to distinguish it from the combustion gas, by providing what is envisaged to be a significant use of such devices as a metonym.

[0006] Traditional large portable heaters use thin-wall steel tubes in the construction of their heat exchangers. The hot combustion gas in these heaters flows through these tubes and the clean air flows amongst the tubes. Heat is transferred from the combustion gas inside the tubes to the tube walls and then from the tube walls to the surrounding air primarily by forced convection.

[0007] Conventional techniques in structuring these tube-based heat exchangers result in heat exchangers that have certain problems. For example, they may have hot spots because it is very challenging to create an even airflow amongst the tubes. These hot spots may lead to premature failure, such as by creating cracks that allow the combustion gasses to escape.

[0008] In particular, many remote areas that may benefit from a portable heater are considered environmentally sensitive. Thus, there is a need to provide a portable heater that is reliable and powerful, yet environmentally safe.

SUMMARY OF THE INVENTION

[0009] The present invention addresses the problems in the art stated above and provides certain advantages over the prior art. The present invention addresses the problem of bulky storage of electricity or requirements that electrical connections be present by, for example, providing a heat exchanger that is capable of operation with fuel-air heat sources.

This ability to use fuel-air sources permits the generation of heat from releases of chemical energy by, for example, combustion as opposed to merely electrochemical reactions and resistive heating techniques.

[0010] The present invention also addresses the problem of unbreathable combustion gasses by permitting the combustion gasses to transfer their heat without contaminating the clean air. This is accomplished by the use of a heat exchanger that separates the flow of combustion gasses and clean air, thereby preventing their admixture. Additionally, after much of the useful heat has been transferred to the clean air, the combustion gasses may be "scrubbed" using conventional filters and techniques to avoid harmful or deleterious effects on release or escape from the system. The present invention may be used in a variety of applications including, for example, to heat a building under construction, to heat a temporary work seat, to provide mobile emergency heat, to heat a warehouse, or to heat an airplane hanger.

[0011] The present invention also addresses the problem of uneven flow around tubes in a heat exchanger. In the present example, the clean air may flow smoothly between a pair of plates in the heat exchanger, and parallel to any bends in those plates. Thus, the clean air does not experience the turbulence found among the tubes. Moreover, as the clean air is heated, it expands. The expansion of the clean air forces it to apply even greater pressure to the surface of the plates.

[0012] The present invention also addresses the problems of hot spots in the system. As explained above, the present invention may allow the clean air to very efficiently and evenly remove heat from the surface of the plates. Because the heat is removed evenly, hotspots and resulting stress fractures or other defects are also avoided.

[0013] The present invention may additionally accrue the advantage of a longer life than prior heaters, because it reduces the incidents of hot spots: a significant cause of failure in heaters. The present invention may also permit the use of stainless steel in plate form. The use of stainless steel may provide the advantage to the system of being rust and corrosion resistant. This advantage may in turn, provide the further advantage of again increasing the longevity of the system.

[0014] The present invention may also accrue the advantage of being suitable for use in very cold conditions. This invention may, for example, be useful in Alaska, Antarctica, or other arctic and sub-arctic areas. In particular, the present invention may be used to provide, for example, 700,000 BTU of heat, which may be of particular value in very cold

environments. Moreover, certain embodiments of the invention may range in thermal output from about 20,000 BTU to about 10,000,000 BTU.

[0015] One embodiment of the present invention may be an apparatus including an enclosure having at least one input and at least one output for a first stream of fluid and at least one input and at least one output for a second stream of fluid, at least three plates secured within the enclosure, wherein the plates are adapted to prevent physical admixture of at least two streams of fluid, and wherein the plates are adapted to transfer heat from at least one of the streams to at least one other of the streams. In such an embodiment the plates may be arranged in a stack. In another such embodiment the stack includes two or more approximately parallel plates. In particular, the plates may be arranged in parallel. Such an arrangement may allow many plates to be somewhat evenly stacked. In a further such embodiment, the stack may be adapted to permit flow of clean air within a first pair of plates, and to permit the flow of combustion gas within a pair of plates that includes only one of the first pair of plates. Thus, the combustion gasses may be directed to flow through a pair of plates, thereby heating these plates; meanwhile, clean air may flow across the other side of each of the plates cooling the plates by transferring the heat to the cool air.

[0016] In another such embodiment, the stack may be adapted to permit flow of clean air and combustion gas respectively within alternating pairs of the plates in the stack. In a further such embodiment, the plates may be bent in two or more locations. Such a bend may create a washboard effect in the flow of gasses that may be perpendicular to the bend, while allowing a smooth laminar flow of gasses parallel to the bend. In yet another such embodiment, the plates may be corrugated. In another such embodiment, the plates may be bent in a direction orthogonal to the flow of at least one of the two streams of fluid.

[0017] In another such embodiment, the plates may comprise a material such as stainless steel, aluminum, galvanized steel, mild steel, aluminized steel, or combinations or alloys thereof. One of ordinary skill in the art will recognize that other metals and other materials may be suited to transfer heat without permitting combustion gasses to mix with clean air. In yet another such embodiment, the plates may include a plate metal. In a further such embodiment, at least one of the streams may include a stream of combustion gas. In a yet further such embodiment, at least one of the streams may include a stream of clean air. In another such embodiment, the fluid may include a fluid such as a gas, a plasma, or a liquid. Additionally, although the invention is described in terms of heating a stream of clean air, one of ordinary skill in the art will recognize that the invention may, for example, be used to

cool a first stream of fluid. In this example, the combustion is cooled while the clean air is heated. In still another such embodiment, the streams of fluid may be disposed orthogonally to one another.

[0018] Another embodiment of the present invention may be an apparatus including a fuel source, an air source, a combustion mechanism, a combustion chamber adapted to receive fuel from the fuel source and air from the air source, and to contain an operative portion of the combustion mechanism, a combustion gas channel, wherein the channel may include an enclosed stack of plates, and an exhaust pipe, and wherein the enclosed stack of plates is adapted to permit the flow of combustion gas between alternating pairs, and clean air between the other pairs. Such an apparatus may be used as a heater. If desired, the clean air may, after passing through the alternating pairs of plates, be directed around the combustion chamber. Such an organization may permit the clean air to obtain additional thermal energy prior to escape from the heater apparatus.

[0019] In another such embodiment, the stack may include two or more approximately parallel plates. In a further such embodiment, the plates may be bent in two or more locations. In yet another embodiment, the plates may be corrugated. In a yet a further embodiment, the plates may be bent in a direction orthogonal to the flow of at least one of the two streams of fluid.

[0020] In another such embodiment, the plates may comprise a material such as, for example, stainless steel, aluminum, galvanized steel, mild steel, and aluminized steel. In a further such embodiment, the plates may include a plate metal. In yet a further embodiment, at least one of the streams may include a stream of combustion gas. In yet another embodiment, the fluid may include a fluid selected from a group consisting of a gas, a plasma, or a liquid. In a still further embodiment, the streams of fluid may be disposed orthogonally to one another.

[0021] Another embodiment of the present invention may be a method including providing at least three plates, disposing the plates to accommodate the intra-plate flow of at least two streams of fluid, adapting the plates to prevent physical admixture of at least two of the streams of fluid, and adapting the plates to transfer heat from at least one of the streams to at least one other of the streams.

[0022] In another such embodiment, the step of disposing may include arranging the plates in a stack. In a further such embodiment, the step of arranging may include disposing the plates approximately parallel to one another. A yet further such embodiment may include

the step of adapting the stack to permit flow of clean air within a first pair of plates, and combustion gas within a pair of plates that may include only one of the first pair of plates. A still further embodiment may include the step of adapting the stack to permit flow of clean air and combustion gas respectively within alternating pairs of the plates in the stack.

[0023] Another such embodiment may further include the step of bending the plates in two or more locations. A further such embodiment may include corrugating the plates. Yet a further such embodiment may include the step of bending including bending the plates in a direction orthogonal to the flow of at least one of the two streams of fluid. In still a further embodiment, the plates may comprise a material selected from a group consisting of stainless steel, aluminum, galvanized steel, mild steel, and aluminized steel.

[0024] In another such embodiment, the plates may include a plate metal. In a further such embodiment, at least one of the streams may include a stream of combustion gas. In yet a further such embodiment, at least one of the streams may include a stream of clean air. In a still further embodiment, the fluid may include a fluid selected from a group consisting of a gas, a plasma, or a liquid. In yet another such embodiment, further including the step of disposing the streams of fluid orthogonally to one another. In still another such embodiment, the plates may be secured by welding.

[0025] Another embodiment of the present invention may be a method including providing a fuel source, providing an air source, providing a combustion mechanism, disposing the combustion in a combustion chamber, adapting the combustion chamber to receive fuel from the fuel source and air from the air source, and to permit the operation of the combustion mechanism, providing a combustion gas channel, wherein the channel may include an enclosed stack of plates, and an exhaust pipe, and adapting the enclosed stack of plates to permit the flow of combustion gas between alternating pairs, and clean air between the other pairs.

[0026] In an embodiment that includes the step of providing a combustion gas channel, the embodiment may include the step of disposing the stack as a stack of approximately parallel plates. Yet another such embodiment may include the step of bending the plates in two or more locations. A further such embodiment may include the step of corrugating the plates. In still a further such embodiment, the step of bending may include the step of bending the plates in a direction orthogonal to the flow of at least one of the two streams of fluid.

[0027] In another such embodiment, the plates may comprise a material selected from a group consisting of stainless steel, aluminum, galvanized steel, mild steel, and aluminized steel. In yet another such embodiment, the plates may include a plate metal. In yet another such embodiment, at least one of the streams may include a stream of combustion gas. In a further such embodiment, the fluid may include a fluid selected from a group consisting of a gas, a plasma, or a liquid. Still a further such embodiment may include the step of disposing the streams of fluid orthogonally to one another. In yet still another such embodiment, the plates may be secured by welding.

[0028] Another embodiment of the present invention may be an apparatus comprising a combustion chamber, a source of electric power, a heater exchanger, and a secondary containment tub surrounding at least the area below the combustion chamber, the source of electric power, and the heat exchanger, wherein the secondary containment tub is operative to prevent liquid leakage. Thus, for example, a secondary containment tank may help to prevent inadvertent leakage of fuels, antifreeze, and lubricants from a heat exchanger.

[0029] Another embodiment of the present invention may be an apparatus for a fuel tank door comprising a hinged panel disposed to be swung between a first position and a second position, the panel having at least a first side and second side, wherein the first position is substantially vertical and the second position is more horizontal than the first position, wherein the first side of the panel is provided with fuel absorbent pads, and wherein the first side of the panel may be shaped approximately like a pan. A panel having a pan shape may have a generally flat central portion substantially surrounded by a generally elevated peripheral portion

[0030] Another embodiment of the present invention may be an apparatus comprising a heat exchanger for exchanging heat between combustion gasses and clean air, a combustion source, a fuel tank, a generator, and an air cooling system for the fuel tank and generator, wherein the cooling system uses air that is in a different stream from the clean air. In such an arrangement, the cooling system may control the temperature of the heater exclusive of the combustion and clean air streams. Thus, the temperature of the fuel and the generator may be separately controlled. This may be advantageous in certain conditions. For example, if the exterior temperature is - 40 degrees Fahrenheit, the temperature of the fuel may be maintained at about 60 degrees Fahrenheit by occasionally allowing outside air to cool the system. This may be accomplished by occasionally using a fan to blow cold air from outside

the system into the system, and by venting the system. The residual and radiant heat from the combustion chamber and heat exchanger may serve to heat the fuel and generator.

[0031] It is understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the invention as claimed. The accompanying drawings illustrating an embodiment of the invention and together with the description serve to explain the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] Figure 1 is a diagram illustrating a construction of an embodiment of a large portable heater according to the present invention.

[0033] Figure 2 is a flow diagram illustrating the method of heat exchange employed by an embodiment of the present invention.

[0034] Figure 3 is a diagram of the present invention illustrating an embodiment of the present invention employing three plates.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0035] It is to be understood that the present invention is not limited to the particular methodology, compounds, materials, manufacturing techniques, uses, and applications, described herein, as these may vary. It is also to be understood that the terminology used herein is used for the purpose of describing particular embodiments only, and is not intended to limit the scope of the present invention. It must be noted that as used herein and in the appended claims, the singular forms "a," "an," and "the" include the plural reference unless the context clearly dictates otherwise. Thus, for example, a reference to "a stream" is a reference to one or more streams and includes equivalents thereof known to those skilled in the art. In addition, as used here, the term "portable devices" includes moveable devices that may require significant effort in moving, such as a heater with a 250 gallon fuel tank. In general, portable is used as an antonym to a permanent fixture.

[0036] Unless defined otherwise, all technical and scientific terms used herein have the same meanings as commonly understood by one of ordinary skill in the art to which this invention belongs. Preferred methods, techniques, devices, and materials are described, although any methods, techniques, devices, or materials similar or equivalent to those described herein may be used in the practice or testing of the present invention. All references cited herein are incorporated by reference herein in their entirety.

[0037] An object of the present invention is to provide, for example, a novel large portable heater that has reduced susceptibility to hot spots. Another object of the present invention is to provide a heater that has an increased life span. A further object of the present invention is to provide a heater that permits very efficient heat transfer. Yet another object of the present invention is to provide a heater that helps to prevent rust and corrosion.

[0038] The heat exchanger of the present invention may used with a variety of fluids and in a variety of environmental applications, as demonstrated, for example, in the descriptions and explanations associated with the figures below.

[0039] In one embodiment of the present invention, a heater may be constructed. This heater may include a combustion apparatus that may include a fuel supply, an air supply, an igniter, and a chamber in which the combustion may take place. In addition to the combustion apparatus, the heater may also contain a heat exchanger.

[0040] Certain embodiments of the present invention may also include certain safety devices. For example, thermal sensors may be positioned at various points around the device to determine whether the device is remaining within the temperature range for which it was designed. Additionally, insulation or firewalls may be added to prevent heat from being unintentionally directed in specific directions, such as towards a control panel for the device. In certain embodiments, a layer of fiberglass insulation may be placed around the firebox. Moreover, the clean air passages may surround the heat exchanger and combustion chamber. Such an arrangement may permit additional heat transfer to the clean air and may also help to insulate the combustion chamber and heat exchanger. One or more secondary containment tubs may be integrated into the heater and may provide additional containment for any fluids (particularly fuels, lubricants, or antifreeze) that are used.

[0041] The fuel supply for the heater may be self-contained. In such an embodiment, the fuel supply may be equipped with a fuel porter for providing fuel to a storage apparatus such as a fuel tank. In one embodiment of the present invention, the fuel tank has a capacity of about 250 gallons. In other embodiments, the fuel tank may have a capacity that may range from about 50 gallons to about 1000 gallons. The fuel tank may be equipped with a no-burp fill spout and drip pan. Such a fill spout may be approximately 4 inches long.

[0042] One of the fuels that may be used in a heater according to the present invention is diesel. If diesel is used, it may be desirable to port the diesel exhaust into the firebox for a cleaner burn. Other fuels, such as kerosene, propane, and butane, may also be used in the

present invention. The design of the heat exchanger of the present invention is thus not dependent on the source of combustion gasses.

[0043] One embodiment of the present invention may be a heater that may be capable of providing about 700,000 BTU of hot air. This may have, as its combustion source, a diesel engine. Such a diesel engine may, for example, be a liquid cool diesel engine (such as a Kubota® D1105-EBG liquid cooled diesel engine (Kubota Corporation, Osaka, Japan)). The engine may be provided with an approximately 20 gallon sump. In certain embodiments it may be desirable to include a sump with enhanced filtration. Use of such a sump may provide the benefit of extending the average time between servicing the heater.

[0044] The firebox of the heater of the present invention may, for example, be constructed from approximately 12 gauge 309 stainless steel. Wiring that is used in conjunction with the present invention may, for example, be Arctic Flex™ wire. Such wire, may, for example, provide wires with a layer of arctic grade PVC insulation within an arctic grade PVC sheath. Wires so insulated and sheathed may remain flexible at -20 degrees Celsius. The use of these materials may help the heater to last longer under severe environmental conditions, by protecting the apparatus from the effects of cold and other weather phenomena.

[0045] Additionally, if a battery is used in connection with a heater according to the present invention, the battery may, for example, be a gel type battery. Use of a gel type battery may provide the benefit of reducing the risk of accidental release of battery acid into the system. A battery may be included for a variety of reasons, including, for example, to aid in starting the generator.

[0046] In certain portable embodiments, it may be desirable to place the heater of the present invention on a chassis for easier transportation. Such a chassis may, for example, be a heavy-duty chassis with a single axel and a trailer hitch.

[0047] In a particular embodiment, it may be advantageous to use an approximately 12 gauge stainless steel firebox. Additionally, an approximately 4,000 CFM blower may be of use in providing a large quantity of clean, warm air from a heater designed according to the present invention. In another embodiment, substitutable fuel nozzles may be used to control the amount of fuel provided in the combustion chamber. In such an embodiment, the size of the nozzle may indirectly determine the temperature of the clean air.

[0048] A heater manufactured with a heat exchanger according to the present invention may be capable of producing a temperature rise of about 210 degrees Fahrenheit

above the ambient temperature. Additionally, a heater according to the present invention may be scaled to provide, for example, between about 20,000 BTU and about 10,000,000 BTU.

[0048] A heater according to the present invention may incorporate a generator. Such a generator may for example, be a generator with a capacity in the range of about 8 kW to about 20 kW.

[0049] A heater according to the present invention may include a reactive thermostat. Such a thermostat may include a snap disk thermostat. The snap disk thermostat may operate to disable the burner in the combustion chamber when a certain temperature (for example, 300 degrees Fahrenheit) is reached. Additionally, in certain embodiments of the present invention, a thermostat may dynamically monitor the output temperature of the clean air, and fire the burner at the appropriate times to keep the temperature of the clean air in the approximate range of 170 degrees Fahrenheit to 200 degrees Fahrenheit.

[0050] A heater exchanger according to the present invention may also be used in other applications, such as heaters based on geothermal, nuclear, or solar energy.

[0051] Figure 1 provides a diagram of a design of a heater embodying an example of the present invention. In this example, combustion gases enter the stack of plates 110 from a first direction 120. These gases flow perpendicular to the folds in the plates. Thus, the gases experience a turbulent "washboard" effect. In contrast, the clean air enters in a direction 130 parallel to the folds in the plates. In such an embodiment a fan may be used to force the stream of clean air across the surface of the plates. In this embodiment the stack of plates has several folds or bends. This number is illustrative only, in other embodiments there may be more or fewer. Additionally, the folds or bends may be replaced by convexities or concavities.

[0052] The combustion gas may be generated in a combustion chamber 140. In this example the combustion gas is next provided to the stack of plates 110. Finally, the combustion gas is fed through a manifold 150 that may contain devices such as filters to treat the combustion gas. Such a manifold 150 may, for example, be referred to as the exhaust stack. A commercial air filter and noise muffler may, for example, be employed to reduce the potentially harmful side effects of releasing the combustion gasses.

[0053] Although it is not shown in this picture, in certain embodiments that may be employed indoors, the combustion gasses may be transported by pipe or other device to an external (e.g., outdoors) location.

[0054] After passing through the primary portion of the heat exchanger, the clean air may be directed through a shroud 160 back along the exterior of the primary portion of the heat exchanger. This may permit the clean air to capture additional heat by convection or radiation from the heat exchanger.

[0055] Figure 2 depicts the method of heat exchange employed by an embodiment of the present invention. For example, in a first combustion step 210, fuel and air may be combusted in a combustion chamber. In a second combustion step 220, the gasses from the first combustion step 210 may be provided to one boundary of the heat exchanger 225. In a third combustion step 230, the combustion gasses may be processed and exhausted. In certain embodiments, the combustion gasses may be at least partially recycled to permit a cleaner burn. Similarly, in a first ventilation step 240, clean air is forced into the system using, for example, a fan. In a second ventilation step 250, the clean air is provided to another boundary of the heat exchanger 225. In the third ventilation step 260, the heated clean air is vented to the area to be heated.

[0056] Figure 3 is a diagram of the present invention illustrating an embodiment of the present invention employing three plates. In this embodiment, a first stream of fluid, such as combustion gas, may enter from the side through one or more first inputs 310. After passing through the apparatus the combustion gas may exit through one or more first outputs 320. Similarly, a second stream of fluid, such as a clean air may enter through one or more second inputs 330 and may subsequently exit through one or more second outputs 340. As shown in this figure, the direction of the flow of clean air and combustion gas may be approximately orthogonal to one another. The flows, however, may be prevented from mixing by plates 350. These plates 350 may be adapted to permit heat transfer as shown by the arrows, but may also be adapted to prevent admixture of clean air and combustion gas. Such plates 350, may, for example, be fabricated from stainless steel or aluminized steel. In certain embodiments, the plates may be bent. The plates may also be welded to the enclosure 360 in which the heat exchange occurs.

[0057] Other embodiments of the invention will be apparent to those skilled in the art from consideration of the specification and the practice of the invention disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope and spirit of the invention being indicated by the following claims.